d" atrocities today. As for the great Egyptian pyramids, what are
but the precise static equivalents of our own space rockets? Both
ices for securing, at an extravagant cost, a passage to heaven for the
ored few.

These colossal miscarriages of a dehumanized power-centered cul-
monotonously soil the pages of history from the rape of Sumer to
blasting of Warsaw and Rotterdam, Tokyo and Hiroshima. Sooner
ater, this analysis suggests, we must have the courage to ask our-
es: Is this association of inordinate power and productivity with
ally inordinate violence and destruction a purely accidental one?

In the working out of this parallel and in the tracing of the archety-
machine through later Western history, I found that many obscure
tional manifestations in our own highly mechanized and supposedly
onal culture became strangely clarified. For in both cases, immense
ns in valuable knowledge and usable productivity were canceled out
equally great increases in ostentatious waste, paranoid hostility, in-
sate destructiveness, hideous random extermination.

. . . This widened interpretation of the past is a necessary move
vard escaping the dire insufficiencies of current one-generation
owledge. If we do not take the time to review the past, we shall not
ve sufficient insight to understand the present or command the fu-
e: for the past never leaves us, and the future is already here.

THE FIRST MEGAMACHINE

Though the [megamachine] came into existence roughly during the same period as the first industrial use of copper, it was an independent innovation, and did not at first utilize any new mechanical aids. But . . . once conceived, [it] was assembled within a short period; and it spread rapidly, not by being imitated, but by being forcefully imposed by kings, acting as only gods or the anointed representatives of gods could act. Wherever it was successfully put together the new machine commanded power and performed labor on a scale that was never even conceivable before. With this ability to concentrate immense mechanical forces, a new dynamism came into play, which overcame, by the magic of success, the sluggish routines, the petty inhibitions, the dull repetitive routines of the basic neolithic village culture. . . .

With the energies available through . . . the megamachine, the very dimensions of space and time were enlarged. Operations that once could hardly be finished in centuries were now accomplished in less than a generation. If whole mountains were not moved, large portions of them were, sometimes in blocks far bigger than any ordinary motor truck could now handle; while, on the level plains, man-made mountains of stone or baked clay, pyramids and ziggurats, arose in response to royal command. No power machines at all comparable to this mechanism were utilized on any scale until watermills and windmills swept over western Europe from the fourteenth century of our era.

From the beginning, this human machine presented two aspects: one negative and coercive, the other positive and constructive. In fact, the second factors could not function unless the first were present. Though the military machine probably came before the labor machine, it was the latter that first achieved an incomparable perfection of per-

formance, not alone in quantity of work done, but in quality. To call these collective entities machines is no idle play on words. If a machine be defined more or less in accord with the classic definition of Reuleaux, as a combination of resistant parts, each specialized in function, operating under human control, to transmit motion and to perform work, then the labor machine was a real machine: all the more because its component parts, though composed of human bone, nerve, and muscle, were reduced to their bare mechanical elements and rigidly restricted to the performance of their mechanical tasks.

Such machines, of immense power and practical utility, had already been invented by kings in the early part of the Pyramid Age, from the end of the fourth millennium on. Just because of their detachment from any external structure, they had paradoxically much fuller capacities for change and adaptation than the more rigid metallic counterparts of a modern assembly line. In fact, it is in the building of the pyramids that we find the first indubitable evidence of the machine's existence, and the first proof of its astonishing efficiency. Wherever kingship spread, the human machine, in its destructive if not its constructive form, always went with it. This holds as true for Mesopotamia, India, China, Cambodia, Mexico, Yucatán, or Peru, as for Egypt.

Let us examine the human machine in its archetypal original form. . . .The pyramid took form as a tomb to hold the embalmed body of the Pharaoh and secure his safe passage into the after-life: though he alone, at first, had the prospect of such a godlike extension of his existence, the very idea of being able to fabricate personal immortality shows an alteration in all the dimension of existence.

Between the first small pyramid, built in the step form we find later in Central America, and the mighty pyramid of Cheops at Giza, the first and the most enduring of the Seven Wonders of the Ancient World, lies the short span of three hundred years. On the ancient time scale for inventions the most primitive form and the final one, never again to be equaled, were practically contemporary. The swiftness of this development indicates a concentration of physical power and technical imagination: for it took far more than faith to move the mountain of stone that composed this ultimate monument. That transformation is all the more striking because the Pharaohs' tombs did not stand alone: they were part of a whole city of the dead, with buildings that housed the priests who conducted the elaborate rituals deemed necessary to ensure a happy fate for the departed divinity.

The Great Pyramid is one of the most colossal and perfect examples of the engineer's art at any period or in any culture. Considering the state of all the other arts in the third millennium, no construction of our own day surpasses this in either technical virtuosity or human audacity.

This great enterprise was undertaken by a culture that was just emerging from the Stone Age, and was long to continue using stone tools, though copper was available for the chisels and saws that shaped building stones for the new monuments.

The actual operations were performed by specialized handicraft workers, aided by an army of unskilled or semiskilled laborers, drafted at quarterly intervals from agriculture. The whole job was done with no other material aids than the "simple machines" of classical mechanics: the inclined plane and the lever, for neither wheel nor pulley nor screw had yet been invented. We know from graphic representations that large stones were hauled on sledges, by battalions of men, across the desert sands. Yet the single stone slab that covers the inner chamber of the Great Pyramid where the Pharaoh lies weighed fifty tons. An architect today would think twice before calling for such a mechanical exploit.

Now, the Great Pyramid is more than a formidable mountain of stone, 755 feet square at the base, rising to a height of 481.4 feet. It is a structure with a complex interior, consisting of a series of passages at different levels that lead into the final burial chamber. Yet every part of it was built with a kind of precision that, as J. H. Breasted emphasized, belongs to the optician's art rather than that of the modern bridge builder or skyscraper constructor. Blocks of stone were set together with seams of considerable length, showing joints of one-ten-thousandth of an inch; while the dimensions of the sides at the base differ by only 7.9 inches, in a structure that covers acres. In short, what we now characterize as flawless machine precision and machine perfection first manifested itself in the building of this great tomb: at once a symbol of the mountain of creation that emerged out of the primeval waters and a visible effort, so far remarkably successful, by purely human measure, to solidify both time and the human body in an eternal form. No ordinary human hands, no ordinary human effort, no ordinary kind of human collaboration such as was available in the building of village huts and the planting of fields, could muster such a superhuman force, or achieve an almost supernatural result. Only a divine king could accomplish such an act of the human will and such a large-scale material transformation.

Was it possible to create such a structure without the aid of a machine? Emphatically not. I repeat, the product itself showed that it was not only the work of a machine, but of an instrument of precision. Though the material equipment of dynastic Egypt was still crude, the patient workmanship and disciplined method made good these shortcomings. The social organization had leaped ahead five thousand years to create the first large-scale power machine: a machine of a hundred

thousand manpower, that is, the equivalent, roughly, of ten thousand horsepower: a machine composed of a multitude of uniform, specialized, interchangeable, but functionally differentiated parts, rigorously marshaled together and coordinated in a process centrally organized and centrally directed: each part behaving as a mechanical component of the mechanized whole: unmoved by an internal impulse that would interfere with the working of the mechanism.

In less than three centuries, this collective human machine was perfected. Once organized and set in motion by the Pharaoh through his chief architect, *the technical competence* and imagination that envisaged the entire design was passed on, by word of mouth, and written instruction, to the component parts: the skilled workers, the overseers and taskmasters, the dumb hands. The kind of mind that designed the pyramid was a new human type, capable of abstraction of a high order, using astronomical observations for the siting of the structure, so that each side was oriented exactly in line with true points of the compass: since at inundation the pyramid site is only one quarter of a mile from the river, a rock foundation—which demanded the removal of sand—was needed. In the Great Pyramid the perimeter of that bed deviates from true level by little more than one-half an inch.

But the workers who carried out the design also had minds of a new order: trained in obedience to the letter, limited in response to the word of command descending from the king through a bureaucratic hierarchy, forfeiting during the period of service any trace of autonomy or initiative; slavishly undeviating in performance. Their leaders could read written orders; for the men employed left their names in red ocher, Edwards tells us, on the blocks of the Meidum pyramid: "Boat Gang," "Vigorous Gang." They themselves would have felt at home today on an assembly line. Only the naked pin-up girl was lacking.

Alike in organization, in mode of work, and in product, there is no doubt that the machines that built the pyramids, and that performed all the other great constructive works of "civilization" in other provinces and cultures, were true machines. In their basic operations, they collectively performed the equivalent of a whole corps of power shovels, bulldozers, tractors, mechanical saws, and pneumatic drills, with an exactitude of measurement, a refinement of skill, and even an output of work that would still be a theme for boasting today.

This extension of magnitude in every direction, this raising of the ceiling of human effort, this subordination of individual aptitudes and interests to the mechanical job in hand, and this unification of a multitude of subordinates to a single end that derived from the divine power exercised by the king, in turn, by the success of the result, confirmed that power.

For note: it was the king who uttered the original commands: it was the king who demanded absolute obedience and punished disobedience with torture, mutilation, or death: it was the king who alone had the godlike power of turning live men into dead mechanical objects: and finally it was the king who assembled the parts to form the machine and imposed the new discipline of mechanical organization, with the same regularity that moved the heavenly bodies on their undeviating course.

No vegetation god, no fertility myth, could produce this kind of cold abstract order, this detachment of power from life. Only one empowered by the Sun God could remove all hitherto respected norms or limits of human endeavor. The king figures, in early accounts, as a being of heroic mold: he alone slays lions singlehanded, builds great city walls, or like Menes turns the course of rivers. That straining ambition, that defiant effort belongs only to the king and the machine that he set in motion.

To understand the structure or the performance of the human machine, one must do more than center attention upon the point where it materializes. Even our present technology, with its vast reticulation of visible machines, cannot be understood on those terms alone. In order to put together a collective machine composed solely of human parts, one needed a complex transmission mechanism, to ensure that commands issued at the top would be swiftly and accurately conveyed to every member of the unit, so that the parts would interlock to form a single operating whole.

Two collective devices were essential, to make the machine work: a reliable organization of knowledge, natural and supernatural: and an elaborate structure for giving and carrying out orders. The first was incorporated in the priesthood, without whose active aid divine kingship could not have come into existence: the second in a bureaucracy: both hierarchical organizations at whose apex stood the temple and the palace. Without them the power complex could not operate. This condition remains true today, even though the existence of automated factories and computer-regulated units conceals the human components essential even to automation.

What would now be called science was an integral part of the new machine system from the beginning. This science, based on cosmic regularities, flourished with the cult of the sun: record-keeping, time-keeping, star-watching, calendar-making, coincide with and support the institution of kingship, even though no small part of the efforts of the priesthood were, in addition, devoted to interpreting the meaning

of singular events, such as the appearance of comets or eclipses of the sun or moon, or natural irregularities, such as the flight of birds or the state of a sacrificed animal's entrails.

No king could move safely or effectively without the support of such organized higher knowledge, any more than the Pentagon can move today without consulting scientists, "games theorists," and computers, a new hierarchy supposedly less fallible than entrail-diviners, but to judge by their repeated miscalculations, not notably so. To be effective, this kind of knowledge must remain a priestly monopoly: if everyone had equal access to the sources of knowledge and to the system of interpretation, no one would believe in infallibility, since its errors could not be concealed. Hence the shocked protest of Ipu-wer against the revolutionaries who overthrew the Old Kingdom was that the "secrets of the temple lay unbared"; that is, they had made "classified information" public. Secret knowledge belongs to any system of total control. Until printing was invented, this remained a class monopoly.

Not the least affiliation of kingship with the worship of the sun is the fact that the king, like the sun, exerts force at a distance. For the first time in history, power became effective outside the immediate range of hearing and vision and the arm's reach. No military weapon by itself sufficed to convey such power: what was needed was a special form of transmission gear: an army of scribes, messengers, stewards, superintendents, gang bosses, and major and minor executives, whose very existence depended upon their carrying out the king's orders, or those of his powerful ministers and generals, to the letter. In other words, a bureaucracy: a group of men, capable of transmitting and executing a command, with the ritualistic punctilio of a priest, the mindless obedience of a soldier.

To fancy that bureaucracy is a relatively recent institution is to ignore the annals of ancient history. The first documents that attest the existence of bureaucracy belong to the Pyramid Age. In a cenotaph description at Abydos, a career official under Pepi I, in the Sixth Dynasty, c. 2375 B.C., reported: "His majesty sent me at the head of this army, while the counts, while the Seal-bearers of the King of Lower Egypt, while the sole companions of the Palace, while the nomarchs (governors) and *mayors* of Upper and Lower Egypt, the companions and chief dragomans, the chief prophets of Upper and Lower Egypt, and the Chief bureaucrats were (each) at the head of a troop of Upper or Lower Egypt, or of the villages and towns which they might rule."

Not merely does this text establish a bureaucracy: it shows that the division of labor and specialization of functions necessary for efficient mechanical operation had already taken place in the organization that,

as executors of the sovereign's will, already controlled the operations of both the military and the labor machine. This development had begun at least three dynasties before, not by accident, with the building of the great stone pyramid of Djoser at Sakkara. [John A.] Wilson observes, in *City Invincible,* that "we credit Djoser, not only with the beginnings of monumental architecture in stone in Egypt, but also with the setting up of a new monster, the bureaucracy." This was no mere coincidence. And W. F. Albright, commenting upon this, pointed out that "the greater number of titles found in sealings of the First Dynasty . . . certainly pre-supposes an elaborate officialdom of some kind."

Once the hierarchic structure of the human machine was established, there was no limit to the number of hands it might control or the power it might exert. The removal of human dimensions and organic limits is indeed the chief boast of the authoritarian machine. Part of its productivity is due to its use of unstinted physical coercion to overcome human laziness or bodily fatigue. Occupational specialization was a necessary step in the assemblage of the human machine: only by intense specialization at every part of the process could the superhuman accuracy and perfection of the product have been achieved. The large-scale division of labor throughout industrial society begins at this point.

The Roman maxim that the law does not concern itself with trifles applies likewise to the human machine. The great forces that were set in motion by the king demanded collective enterprises of a commensurate order. These human machines were by nature impersonal, if not deliberately dehumanized; they had to operate on a big scale or they could not work at all; for no bureaucracy, however well organized, could govern a thousand little workshops, each with its own traditions, its own craft skills, its own willful personal pride and sense of responsibility. So the form of control imposed by kingship was confined to great collective enterprises.

The importance of this bureaucratic link between the source of power, the divine king, and the actual human machines that performed the works of construction or destruction can hardly be exaggerated: all the more because it was the bureaucracy that collected the annual taxes and tributes that supported the new social pyramid and forcibly assembled the manpower that formed the new mechanical fabric. The bureaucracy was, in fact, the third type of "invisible machine," co-existing with the military and labor machines, and an integral part of the total structure.

Now the important part about the functioning of a classic bureaucracy is that it originates nothing: its function is to transmit, without alteration or deviation, the orders that come from above. No merely

local information or human considerations may alter this inflexible transmission process—except by corruption. This administrative method ideally requires a studious repression of all the autonomous functions of the personality, and a readiness to perform the daily task with ritual exactitude. Not for the first time does such ritual exactitude enter into the process of work: indeed, it is highly unlikely that submission to colorless repetition would have been possible without the millennial discipline of religious ritual.

Bureaucratic regimentation was in fact part of the larger regimentation of life, introduced by this power-centered culture. Nothing emerges more clearly from the Pyramid texts themselves, with their wearisome repetitions of formulae, than a colossal capacity for enduring monotony: a capacity that anticipates the universal boredom achieved in our own day. Even the poetry of both early Egypt and Babylonia reveals this iterative hypnosis: the same words, in the same order, with no gain in meaning, repeated a dozen times—or a hundred times. This verbal compulsiveness is the psychical side of the systematic compulsion that brought the labor machine into existence. Only those who were sufficiently docile to endure this regimen at every stage from command to execution could become an effective unit in the human machine.

Though the human machine was powerful, it was likewise extremely fragile: once the royal power was switched off, it "went dead." The royal machine reached the limit of its capabilities, without doubt, in the construction of the Great Pyramid. Soon after this came a revolt so shattering, so profound, that centuries passed before the severed regions of Egypt could be assembled once more under a single divine ruler. Never was power to be raised to such heights of absolute command again until our own day. But the institutional forces set in motion by this first effort continued to operate. Wherever the army, the bureaucracy, and the priesthood worked together under unified royal command, the technics of unqualified power would resume operation. . . .

In short, none of the destructive fantasies that have taken possession of leaders in our own age, from Hitler to Stalin, from the khans of the Kremlin to the Kahns of the Pentagon, were foreign to the souls of the divinely appointed founders of the first machine civilization. With every increase of effective power, extravagantly sadistic and murderous impulses emerged out of the unconscious: not radically different from those sanctioned, not only by Hitler's extermination of six million Jews and uncounted millions of other people, but by the extermination by

the United States Air Force of [approximately] 180,000 civilians in Tokyo in a single night by roasting alive. When a distinguished Mesopotamian scholar proclaimed that "civilization begins at Sumer" he innocently overlooked how much must be forgotten before this can be looked upon as a laudable achievement. Mass production and mass destruction are the positive and negative poles, historically, of the myth of the megamachine. . . .